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Requirements for Super-Dense Operations for the NGATS Terminal Airspace

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Presented at ICNS 2007
Herndon, VA



Authors of Paper

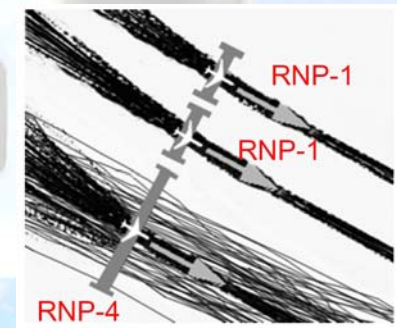
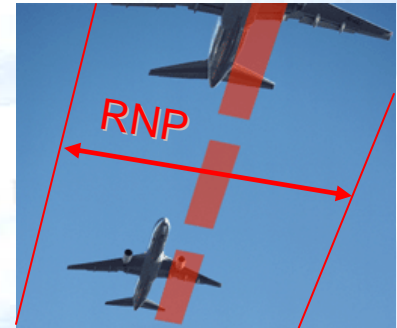
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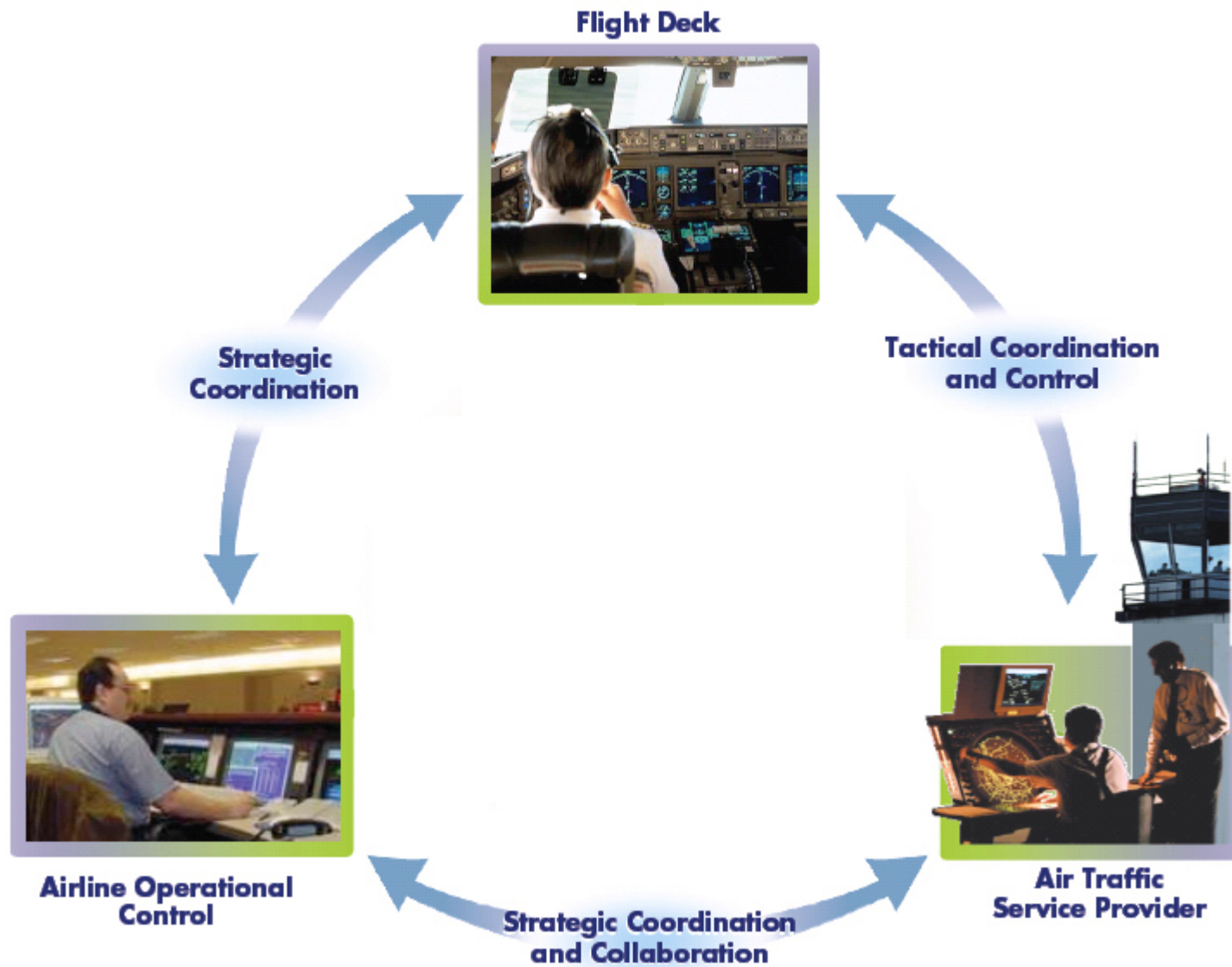


Keywords

- Air Traffic Management (ATM)
- Concept of Operations (ConOps)
- Next Generation Air Transportation Management System (NGATS)
- Super-Dense Operations (SDO)
- Performance-Based Services (PBS)
- Required Navigation Performance (RNP)
- Net-Centric Operations (NCO)
- 4D Trajectories (4DTs)
- Trajectory-Based Operations (TBO)



User Triad



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User Triad



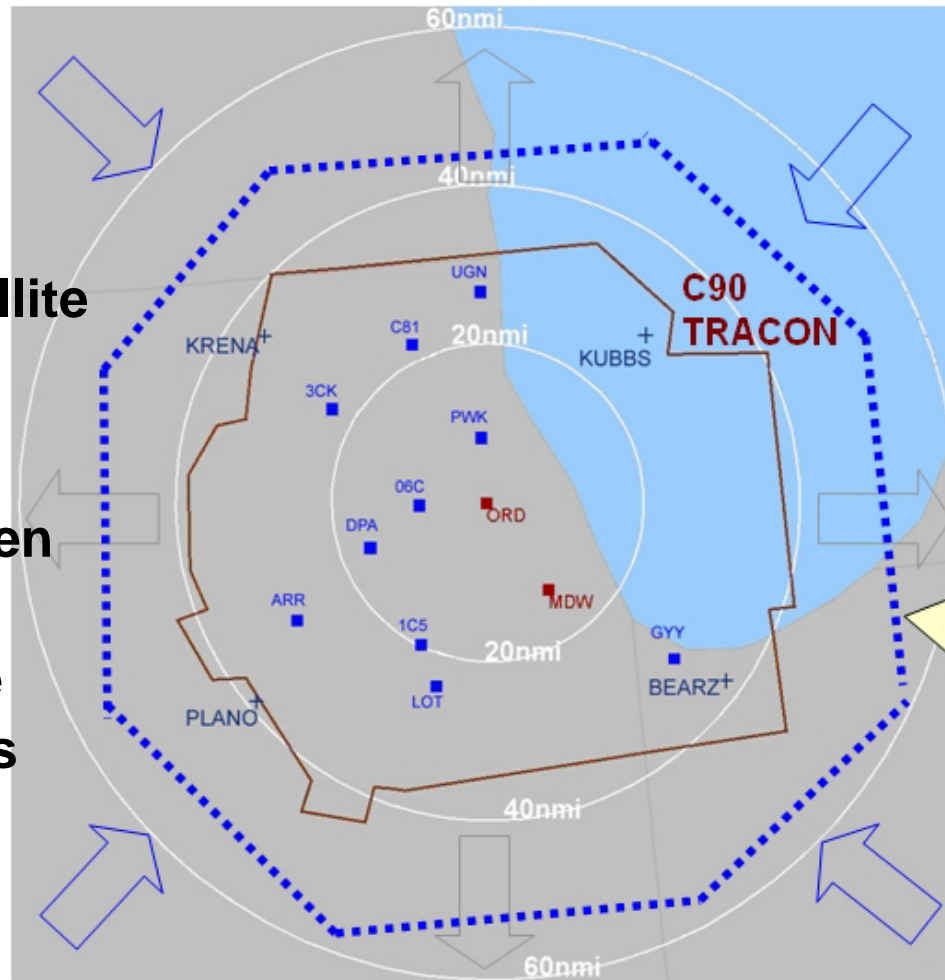
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What is an Airportal?

- A geographic region, usually surrounding a major population region, that contains large, high-density airports and additional satellite airports
- The functional division between Airportal and Airspace is the FAF for arrivals and the initial turn point for departures

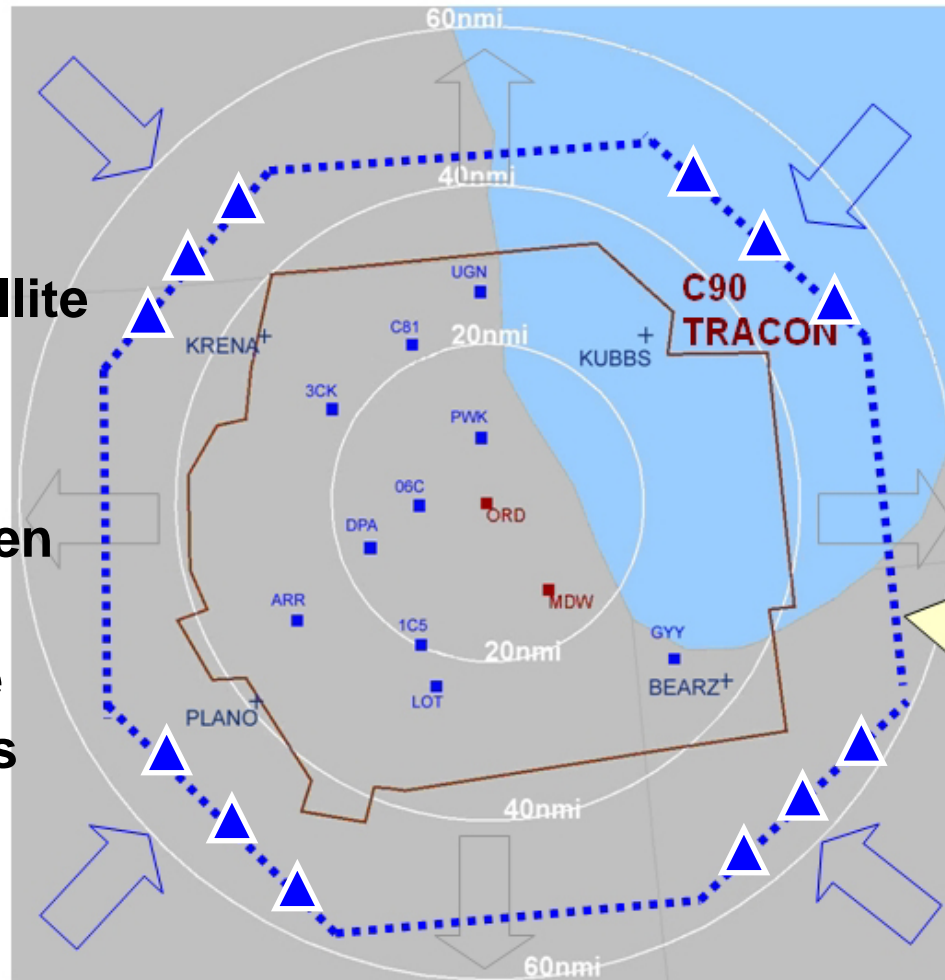


Chicago Airportal would include all these airports and optimize their collective performance as an Airportal system.

Airportal boundary may extend beyond the current day C90 boundaries based on Airportal flow optimization rather than radar coverage limitations.

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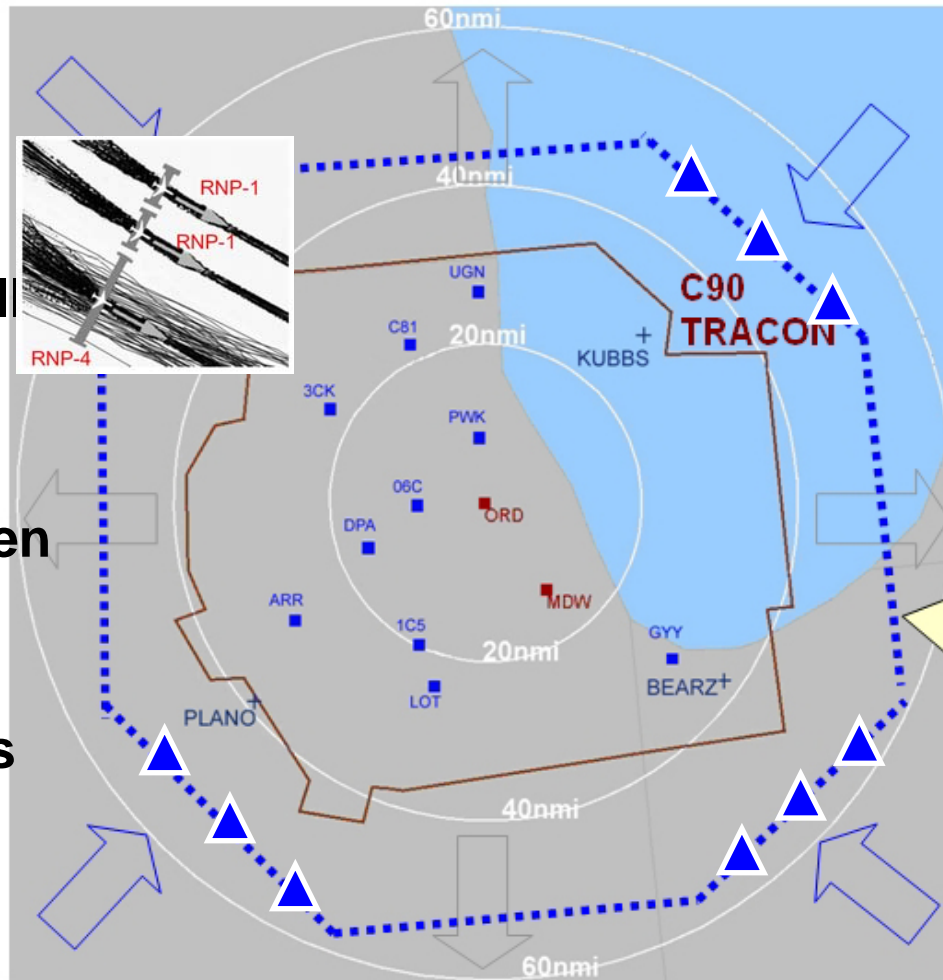


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SDO ConOps

- **National Flow Management**
- **Regional Flow Management**
- **Tactical Flow Management**
- **Tactical Air Traffic Management**
- **Airportal Management**



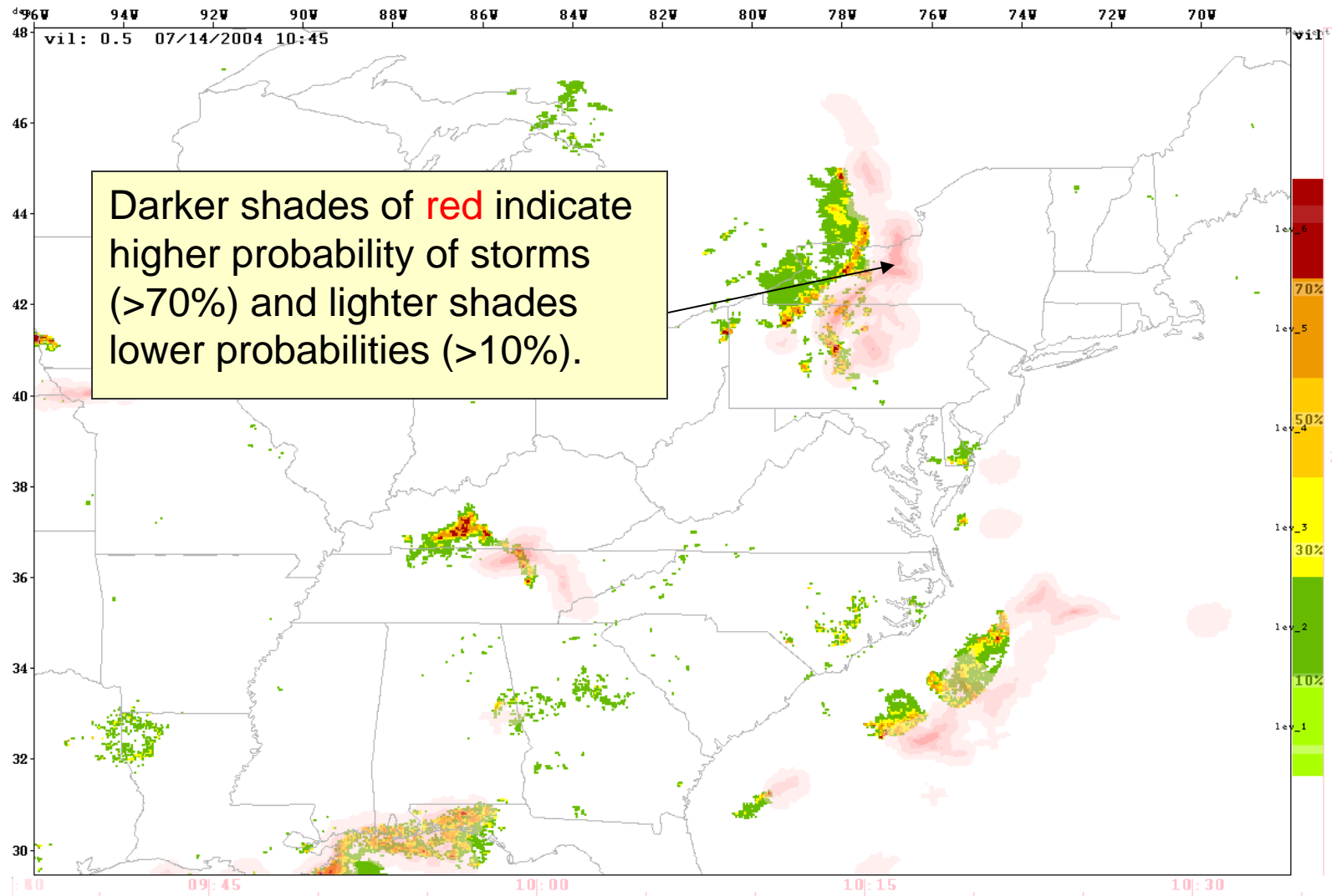
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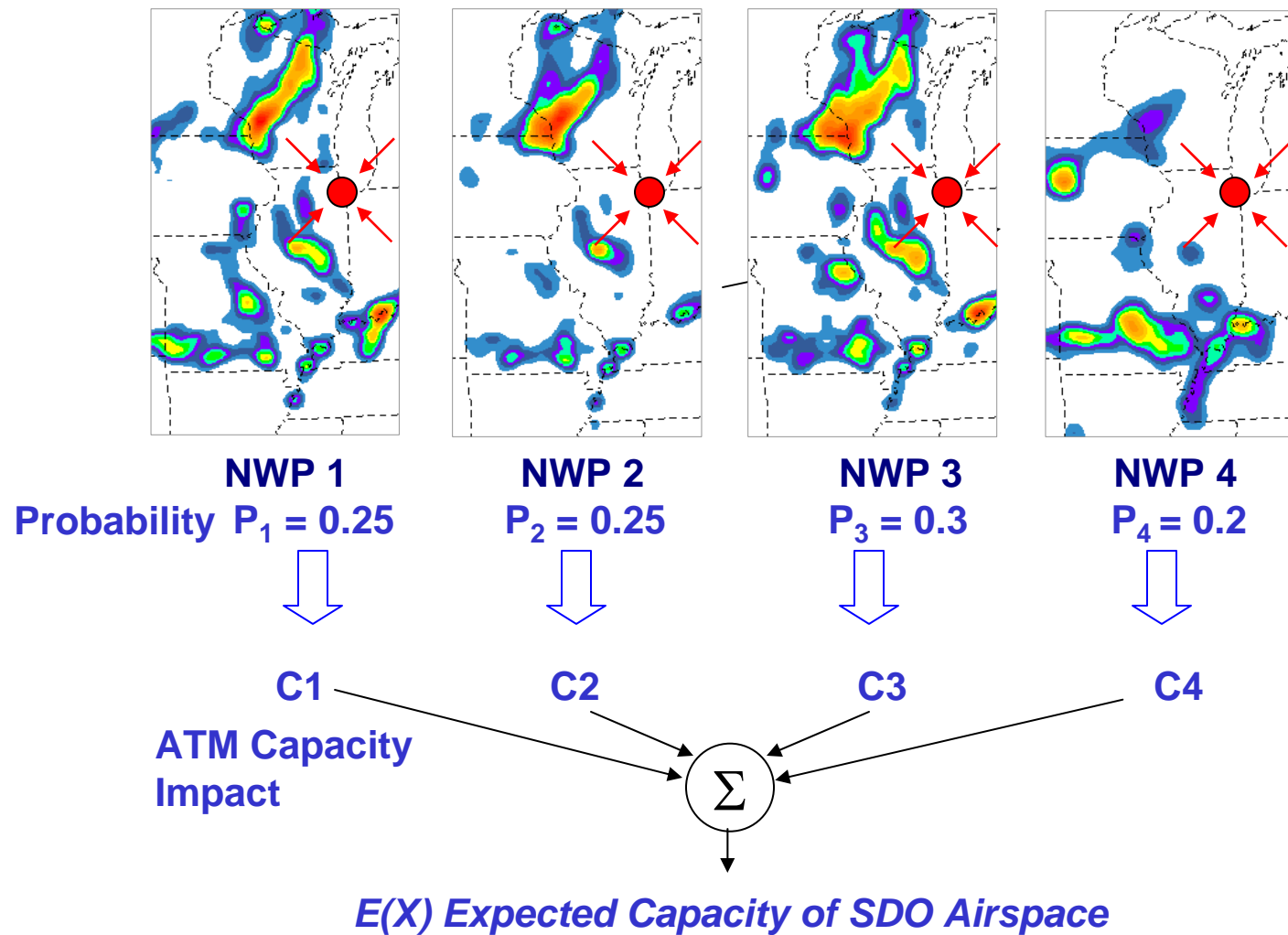
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Probabilistic Weather Forecast Products

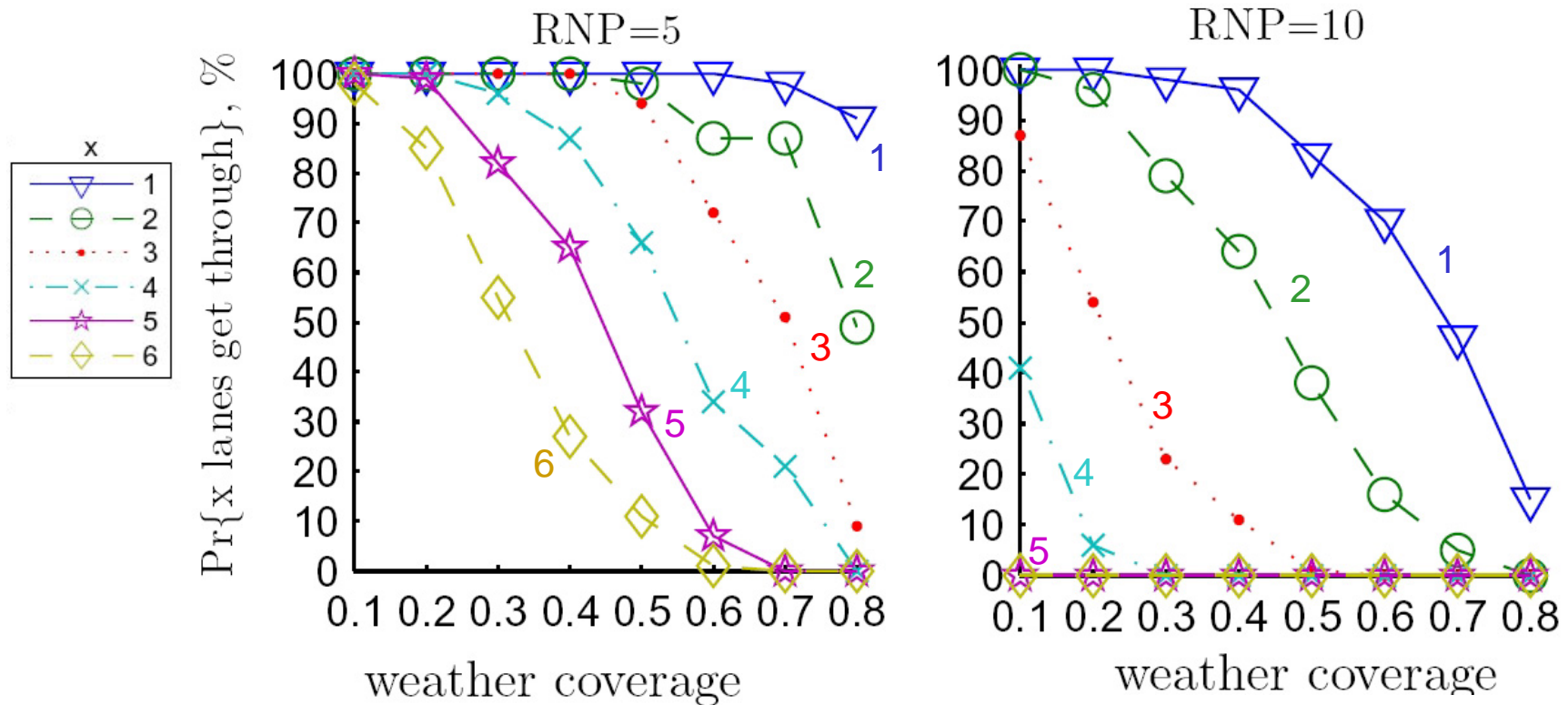


Ensemble Weather Forecasts → Capacity Estimation



Probability x Air Lanes will get through?

- Given a probabilistic weather forecast model, how many air lanes can get through?



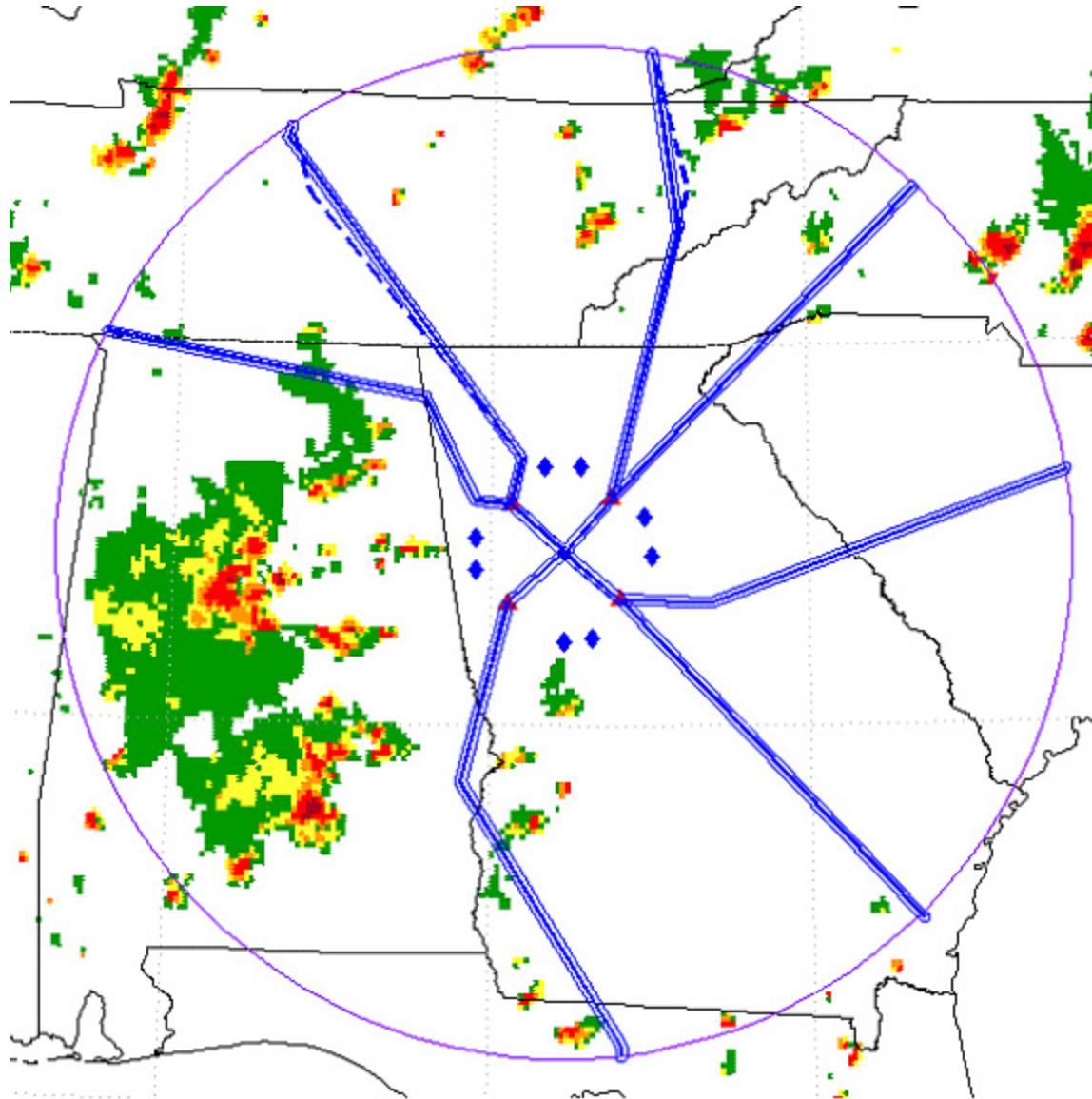
- Probability that x air lanes get through decreases with increasing RNP requirements

Strategically Managing Airportal Flow Rates

- Arrival rates are initially estimated as probabilistic capacities for each cornerpost transition airspace region
- A combination of Ground Delay Program (GDP) and Airspace Flow Program (AFP) is used to manage take off times, route selection, and timed entry into the transition airspace
- Contingency plans must be maintained; speed control, flexible departure time reservoirs for “Tier 1” airports, cornerpost swaps to balance demand on the fixes, and in the worst case, and adaptable holding patterns

Dynamic Transition Airspace Routing

- RNP-2



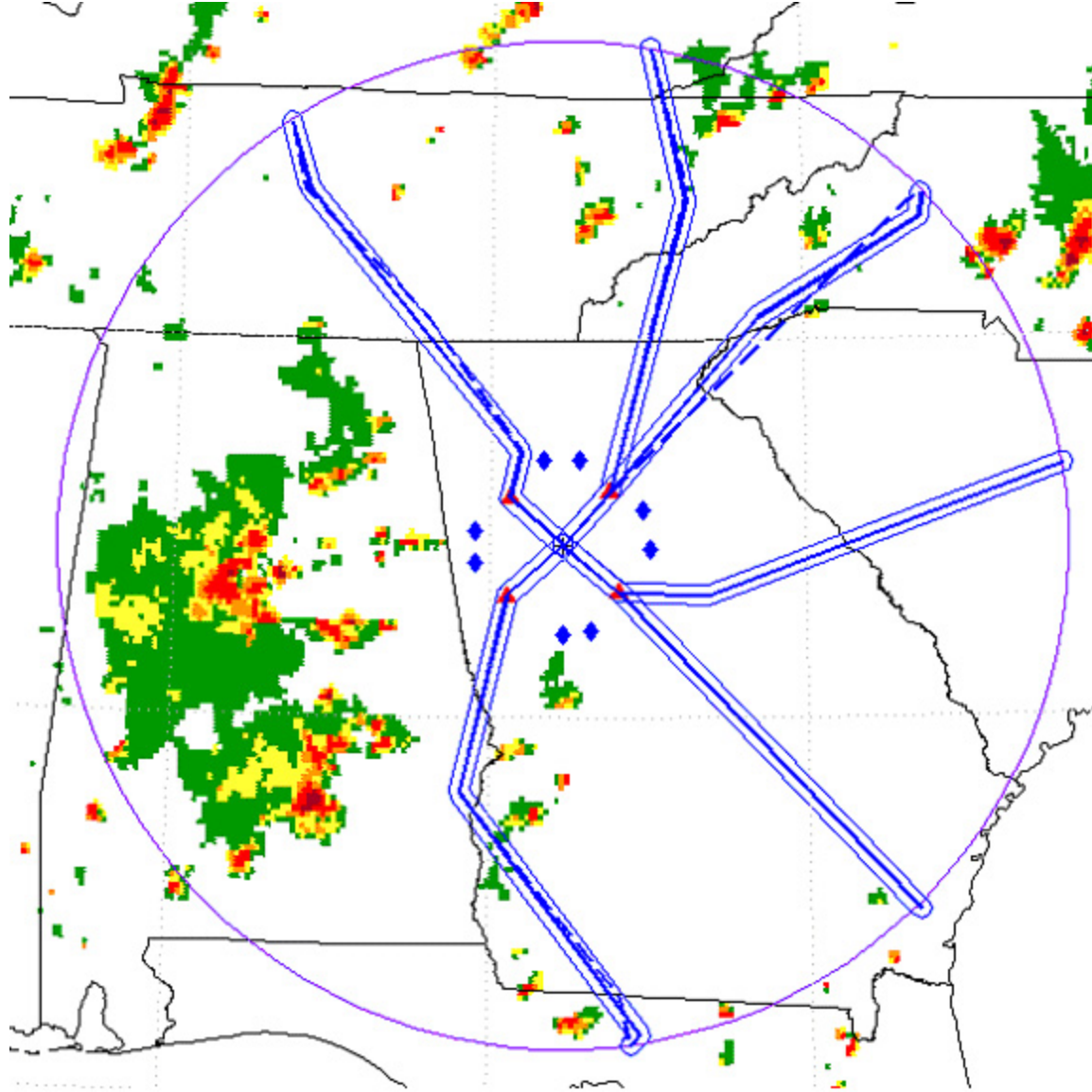
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Dynamic Transition Airspace Routing

- RNP-4

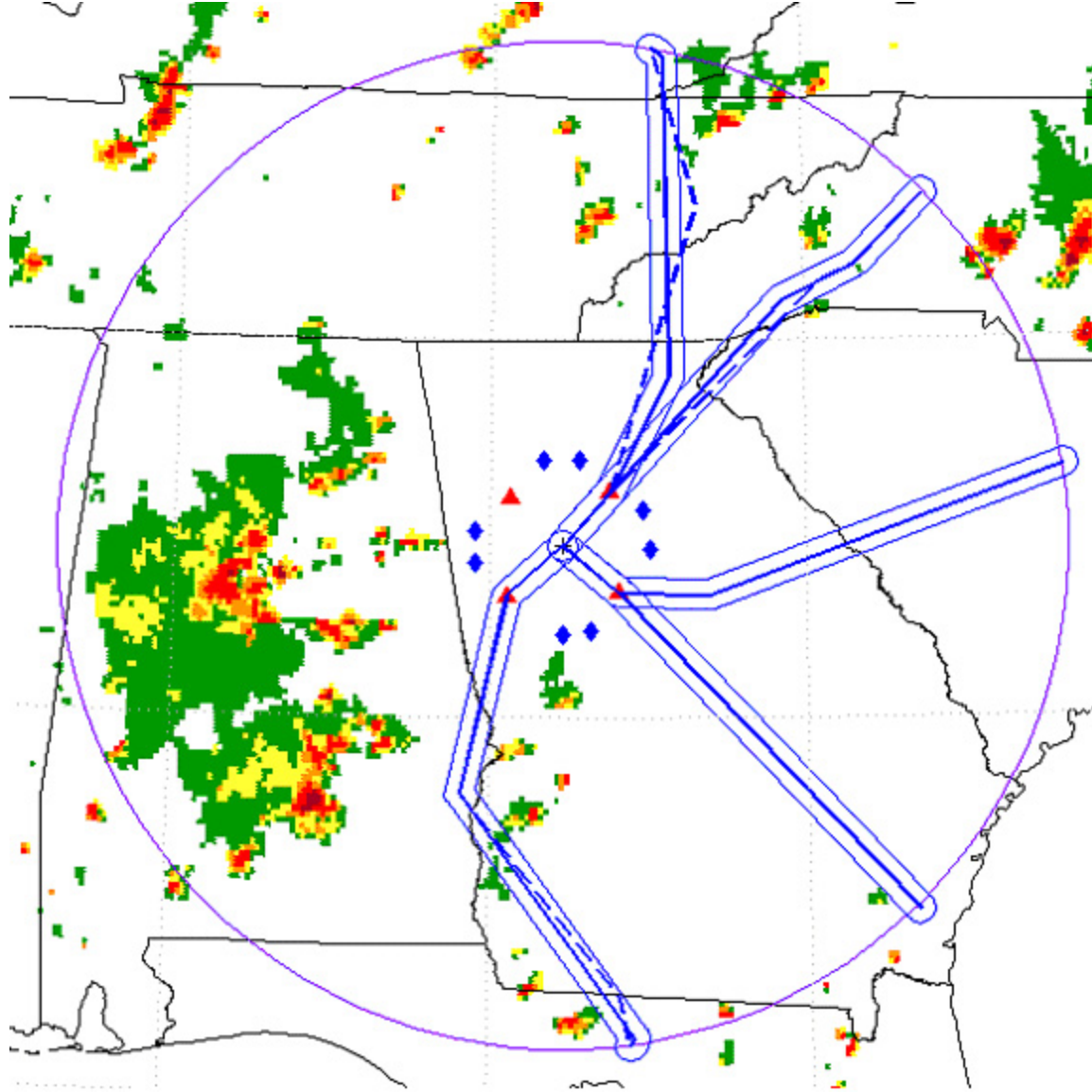


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Dynamic Transition Airspace Routing

- RNP-6

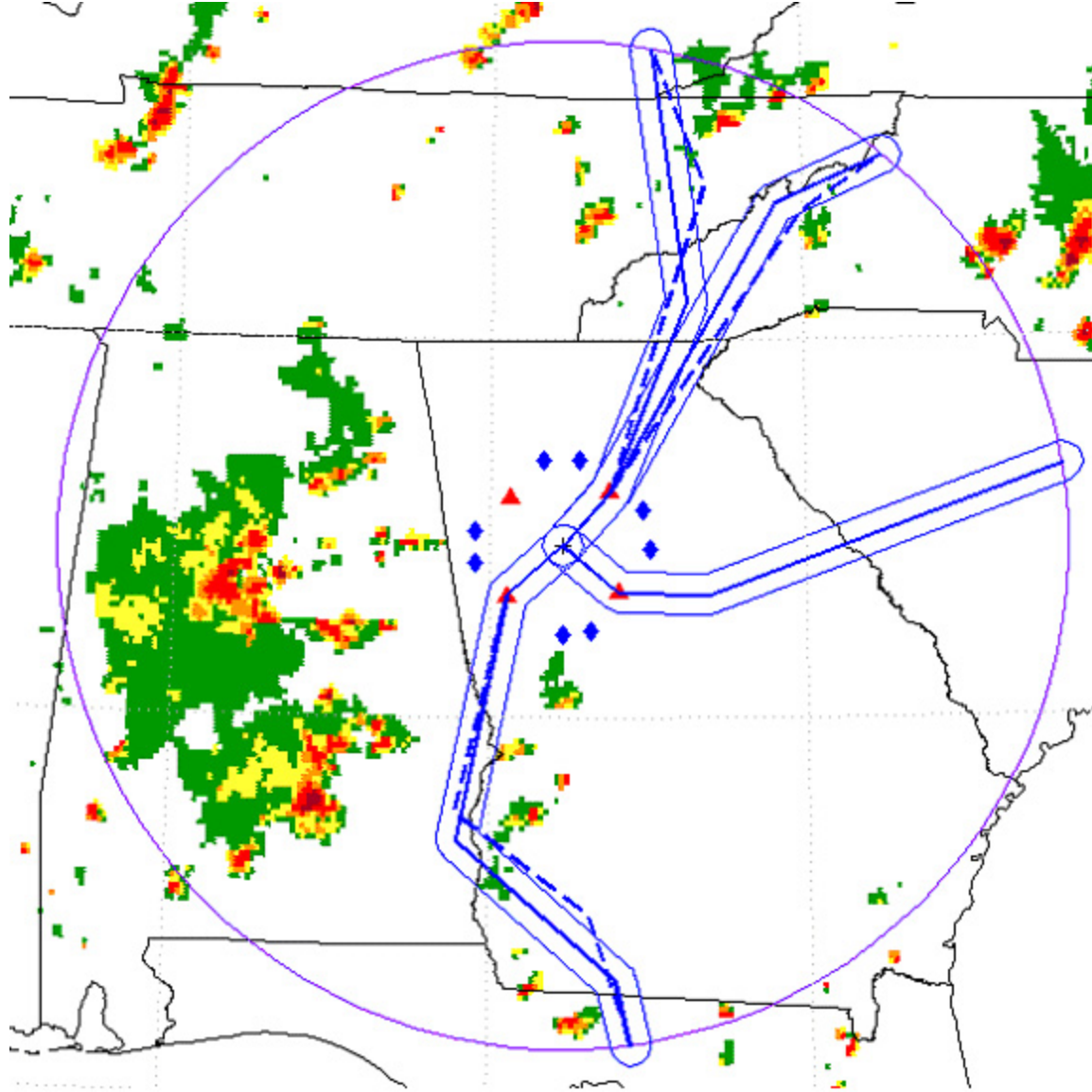


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Dynamic Transition Airspace Routing

- RNP-8

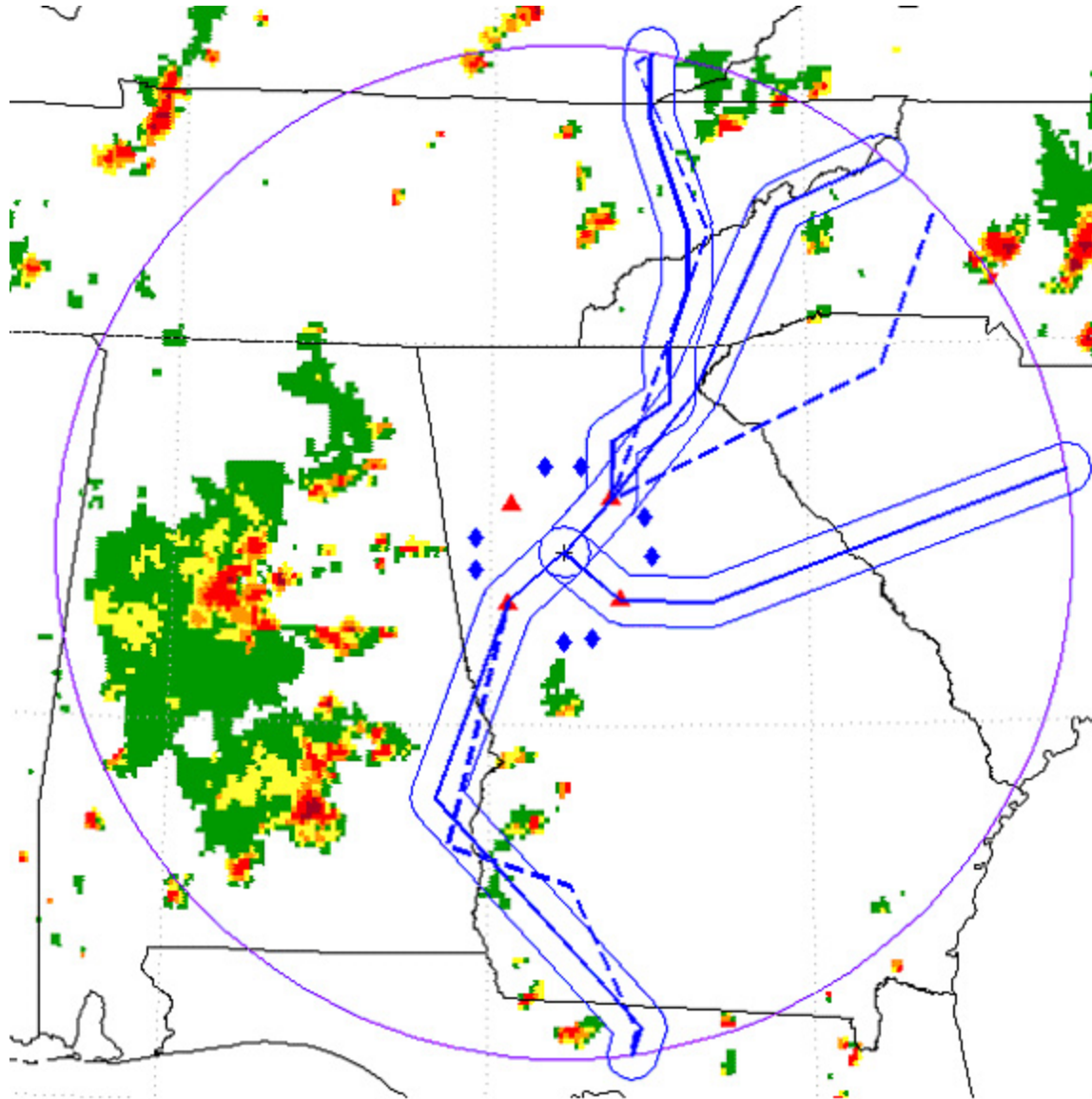


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Dynamic Transition Airspace Routing

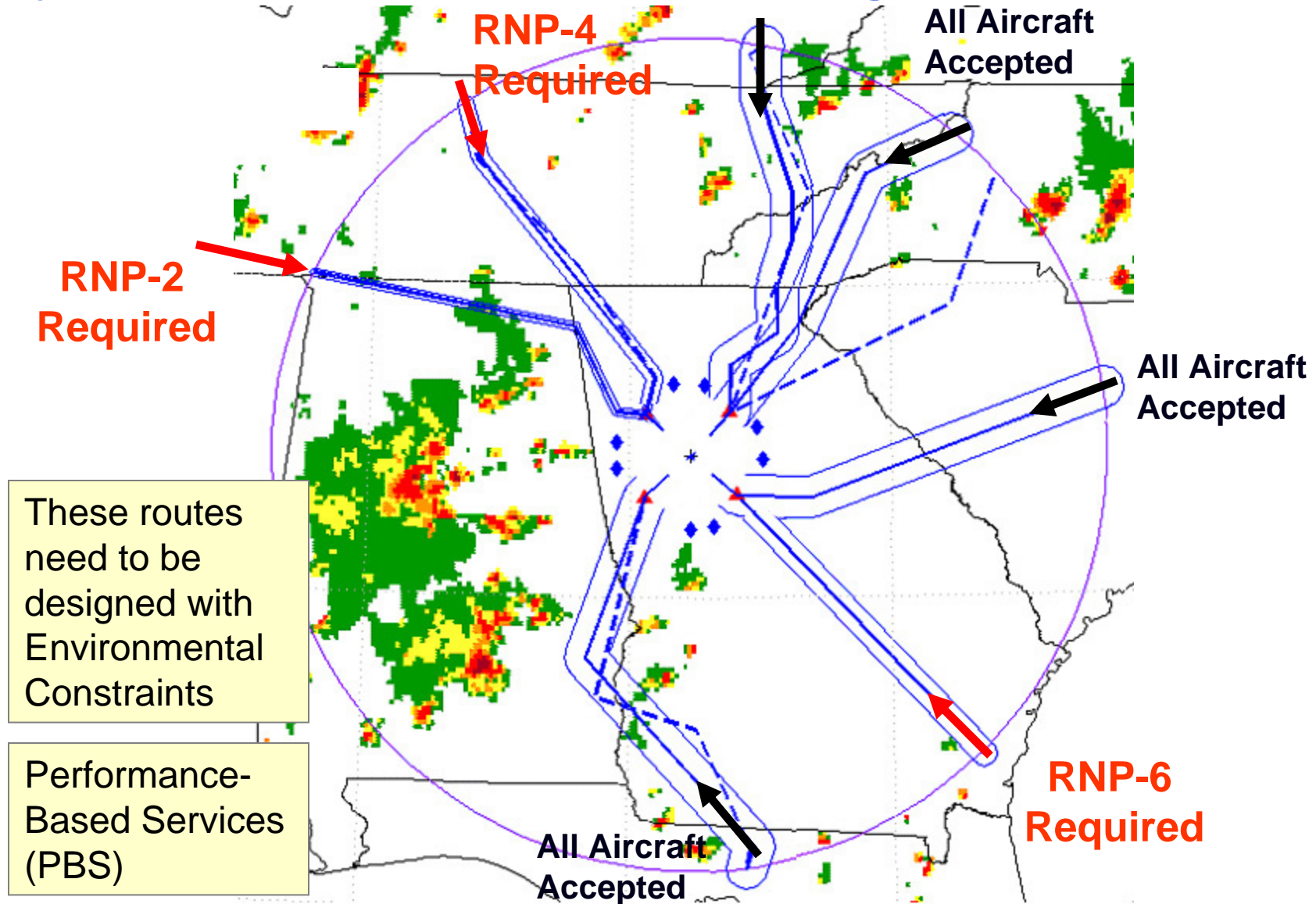
- RNP-10



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Dynamic Transition Airspace Routing Requirements

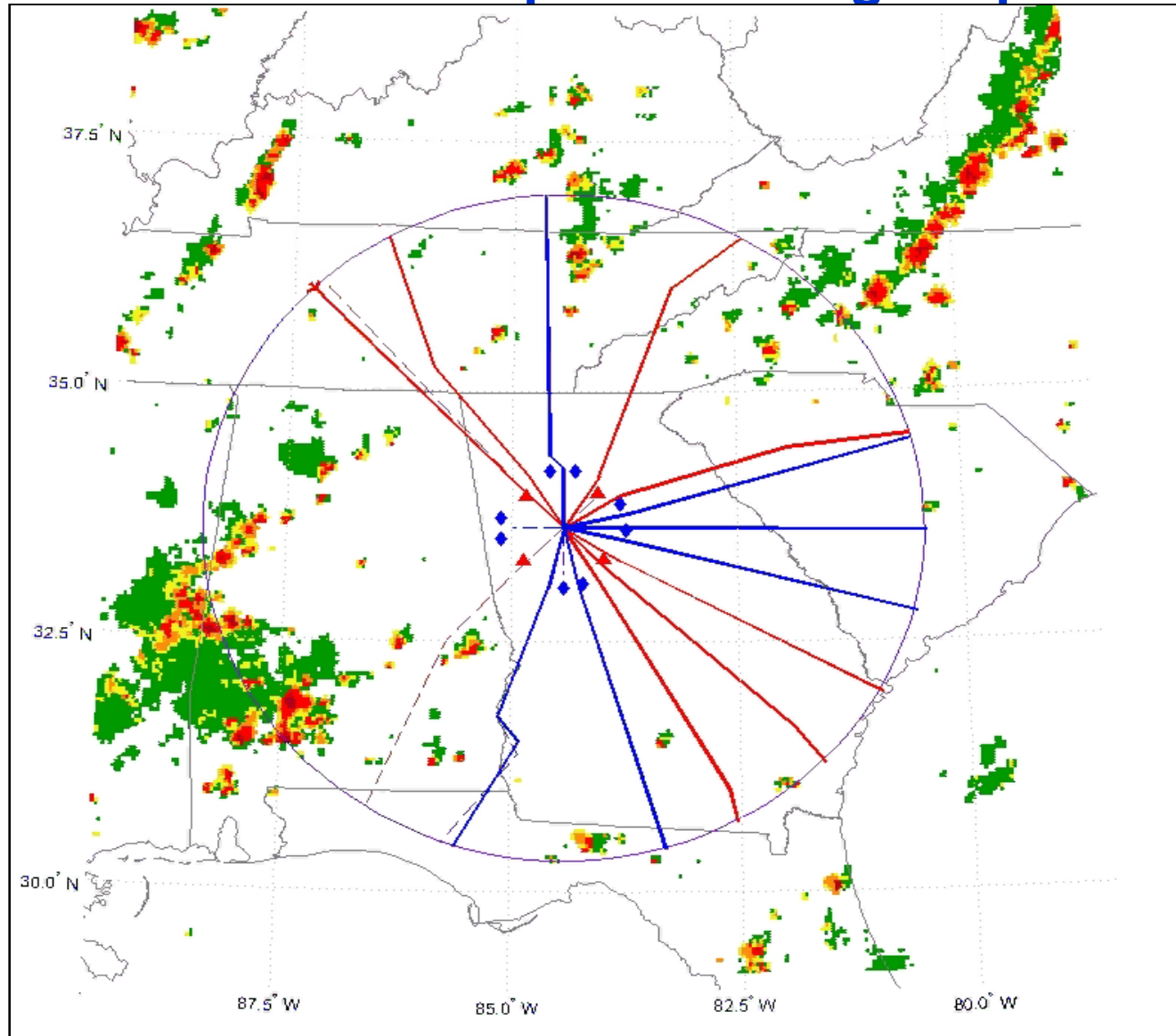


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Dynamic Transition Airspace Routing Requirements



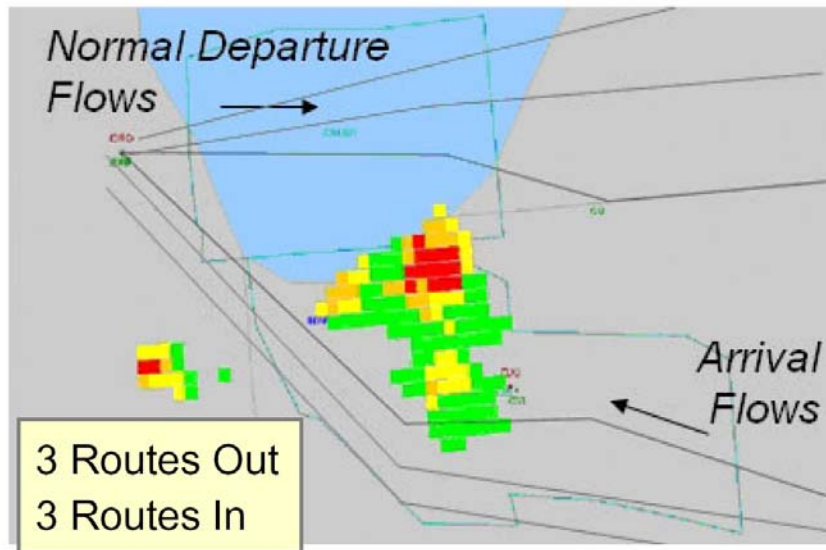
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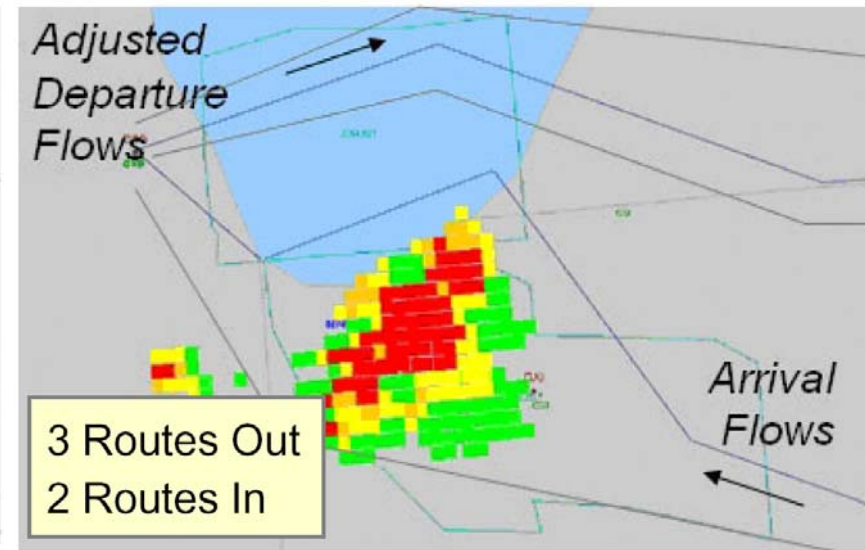
Tactical Air Traffic Control

- **Equipped aircraft are provided specific 4DT via data link**
- **Automated Ground-based Separation Assurance for most aircraft → 4DT into 4D FMS**
- **Reduced Lateral Separations to support Parallel routes to metering fixes and to the runways**
- **Continuous Descent Approaches reduces environmental impact**

Number & Location of Arrival & Departure fixes may Vary



Departure Flows
Unaffected by
Arrival Flows



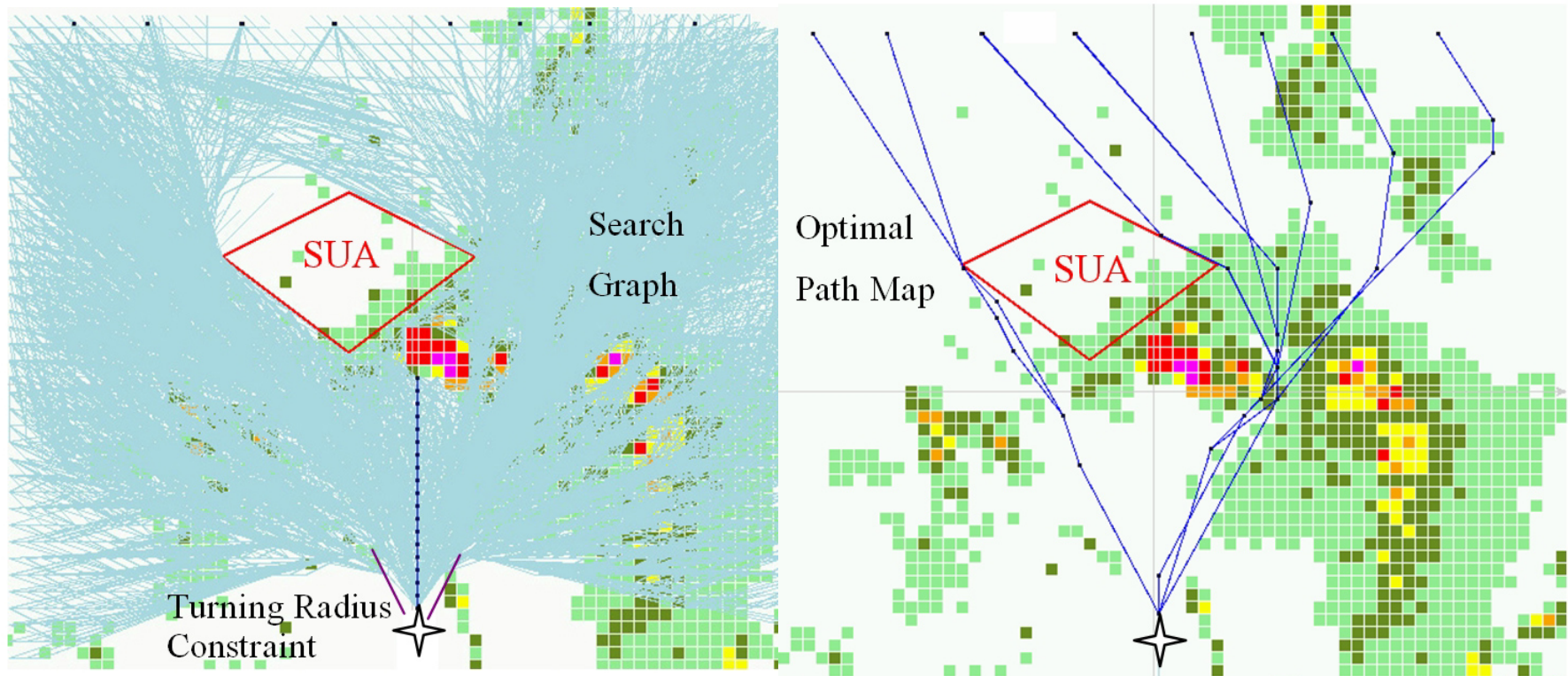
Departure Flows
And Arrival Flows
Are Coupled

- Requires Reduced Lateral Separation Requirements
- Dynamic Airspace Configuration Changes Needed

Airportal Management

- **Increased Volume of Traffic to Satellite Airports within the Airportal**
- **Parallel Runway Procedures**
 - Independent Closely Spaced Parallel Approaches in Low Visibility (as close as 2500 ft apart)
 - Dependent Very Closely Spaced Parallel Runways (as little as 750 ft apart)
- **Wake Vortex sensing and 4DT adjustment for maximum throughput**
- **Coordinated Runway Configuration Changes for the Airports in the Airportal**

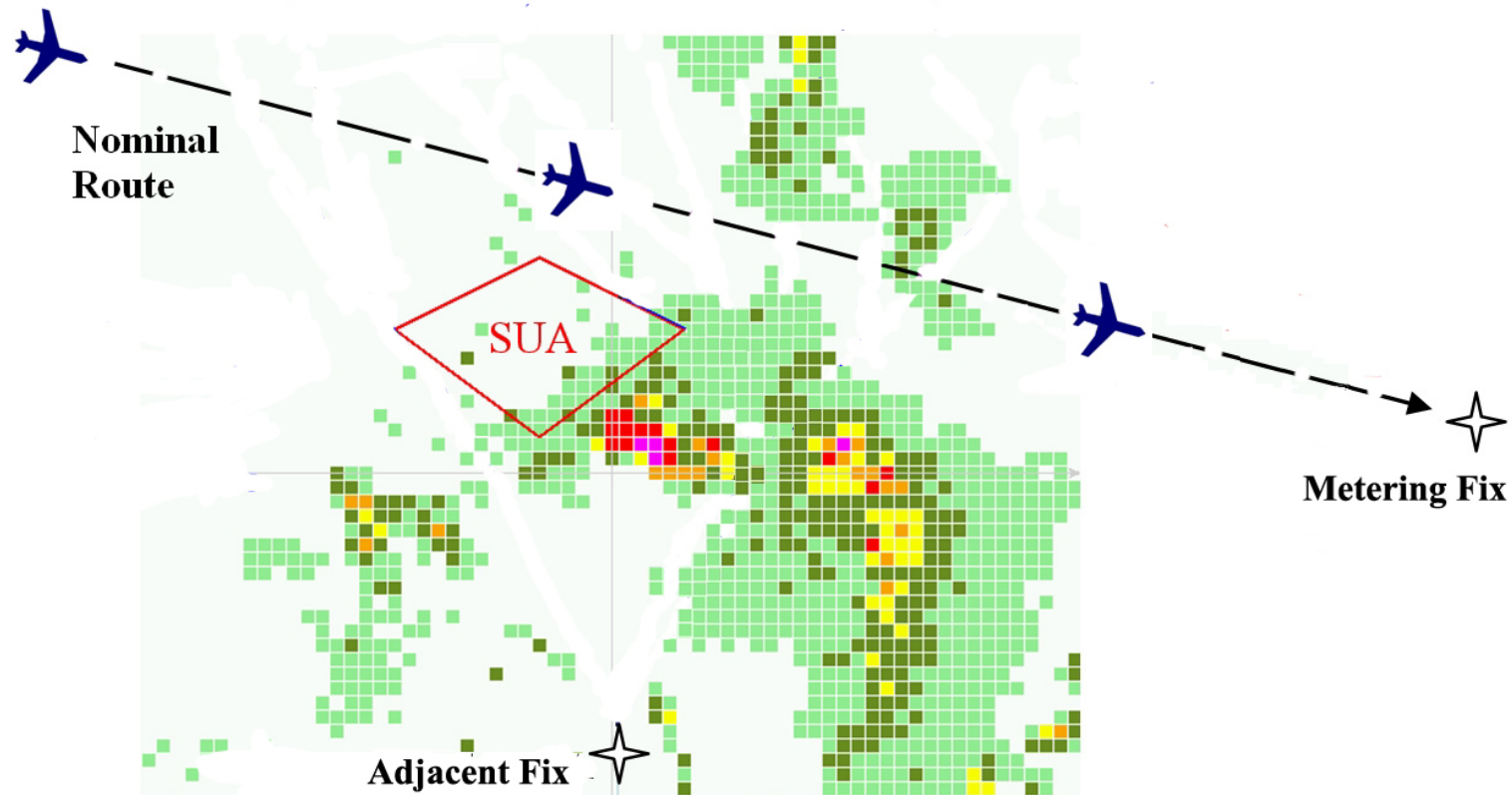
Contingency Planning to Address Unplanned Uncertainties



Search for All
Routes to a Fix

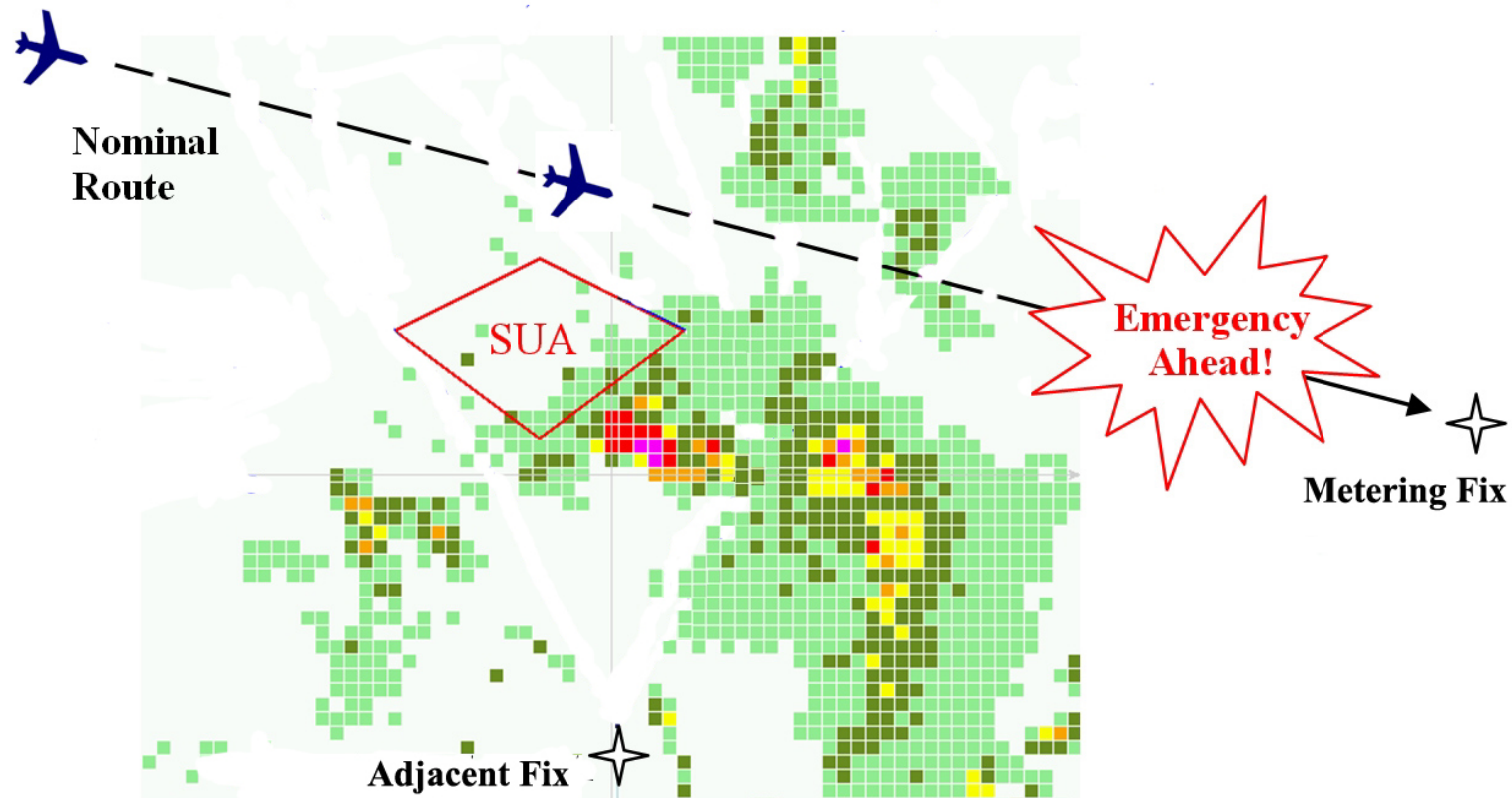
Optimal Path Map (OPM)
for All Routes to a Fix

Contingency Planning to Address Unplanned Uncertainties



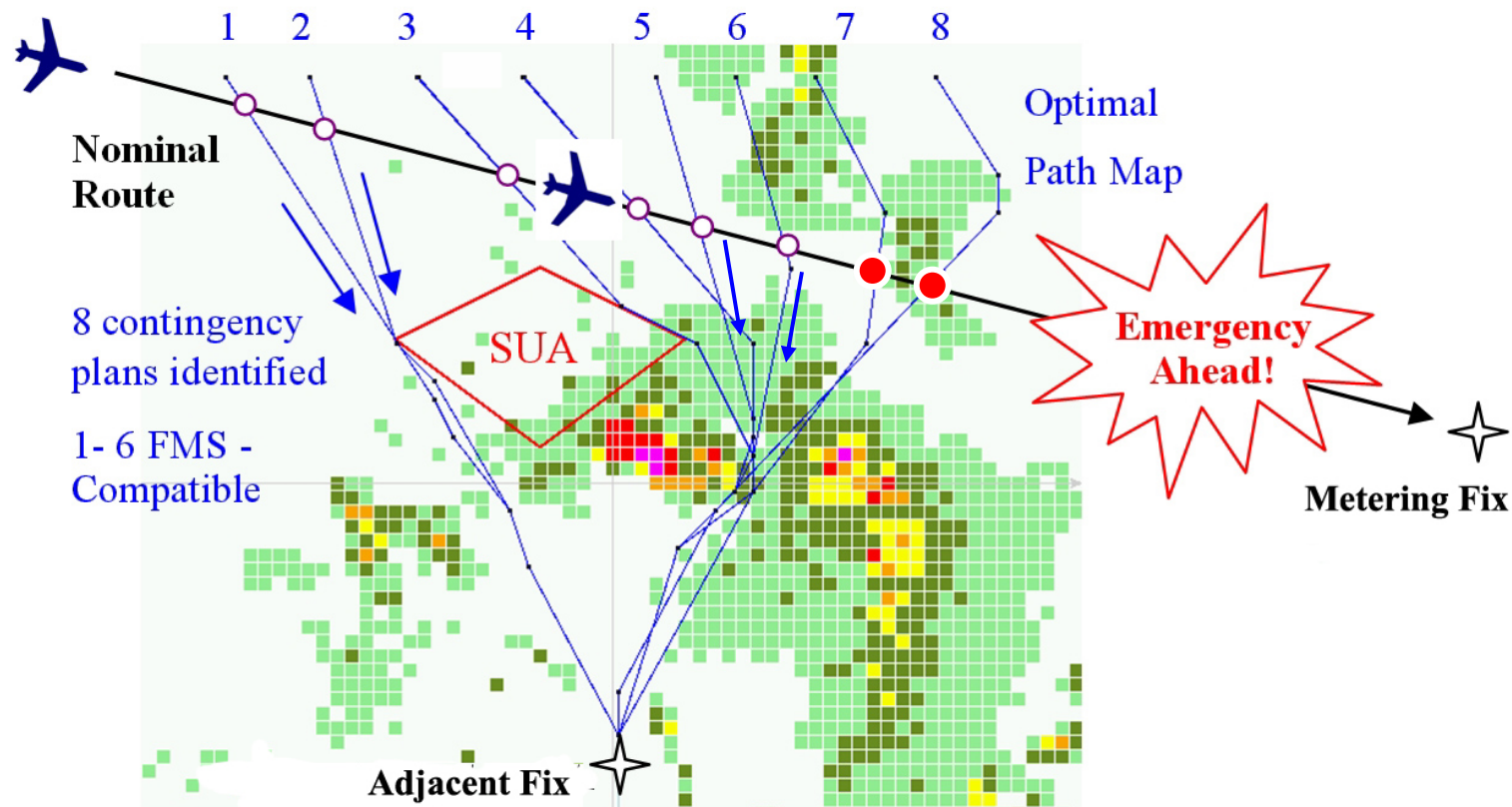
Intersection of Nominal Route and OPM to an alternate Destination provides Contingency Plan Options
(turn constraints need to be checked for intersection point only)

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Contingency Planning to Address Unplanned Uncertainties



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Next Steps

- **Refine the NGATS Operational Concept for SDO for the Terminal Area**
- **Derive Theories for the Estimation of Airspace Capacity (Transition Airspace; Deterministic and Probabilistic)**
- **Derive Optimization Algorithms:**
 - **National Flow Management to a SDO Terminal**
 - **Regional Flow Management to/from a SDO Terminal**
 - **Tactical Flow Management (Contingency Planning)**
- **Perform Trade-off Studies and Proof of Concept Demonstrations**

Point of Contact

